

An Industry Perspective on the Need for Measurement and Metrology Standards for Nanotechnology

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Abstract

Electrical measurements provide the underpinning for many nanotechnology discoveries. Instrumentation suppliers must continue to develop new techniques and equipment to support cutting edge research. Measurement and Metrology Standards will be required for the commercialization of nanotech-based products so that repeatable and verifiable measurements can be performed.

Historically, many scientific advances occur only after suitable investigative instruments become available. Today, tools such as the Atomic Force Microscope (AFM), the Scanning Electron Microscope (SEM), and Semiconductor Characterization Systems help nanotech researchers visualize, resolve, and perform electrical characterization of nanoscale materials and devices. But for electrical measurements, we need to ask ourselves whether or not Volts, Ohms, and Amps mean the same thing on the nanoscale as they do on a macro or micro scale. If Ohms Law does not mean the same thing on the nanoscale, what references do we compare any measurement to? How do we measure accurately and precisely?

Today, researchers from various disciplines, from the college level to major government and industrial research centers, are asking instrumentation companies how to make sensitive measurements on nanoscale materials and electronics. But are the correct tools and methods being used? We are only now beginning to scratch the surface on the types of metrology and measurement standards needed to compare and verify data.

Developing measurement and metrology standards must be a cooperative effort between instrumentation suppliers, user organizations, standards organizations, industry, and academia. Organizations, such as NIST, must work with many industry partners in order to develop the next generation of instruments, standards, and measurement methods and protocols that can be agreed upon, and testing structures that will allow for repeatable and verifiable data. Once these are in place, startup companies and large corporations will be able to perform incoming inspection so they can be assured that the nanomaterials they purchase are exactly what they are purchasing. Next generation electronics can be manufactured and tested to meet the demands of consumer electronics.

Many challenges lie ahead. Time is critical. We need to know what we are measuring. Advanced microscopes, probes, and measurement workstations have opened up a whole new world with many potentials and promises. By working together, we can develop knowledge that will create solutions to the many problems that are core issues in the development of novel materials and electrical components. It is imperative that measurement standards, protocols, structures, and reference tools be developed and agreed upon in order to move forward. This will allow commercial manufacturing and

production to take place. And it will be the new the products from Nanotechnology research that fuel the economy of the world. But only until we have agreed upon standards and methodologies can we then see the economic impact that has been projected.

In the presentation, we will discuss electrical measurement challenges associated with low level electrical measurements made on nanoscale devices and components. We will present examples from our own experiences and share our insights into measurement challenges that standards will have to address. The talk will illustrate how Keithley is utilizing IEEE 1650: IEEE Standard Test Methods for Measurement of Electrical Properties of Carbon Nanotubes as a pre-competitive marketing tool.